Responses to Comments

from CDH, EPA, and PRC
on
Technical Memorandum No. 5
Exposure Assessment
Human Health Risk Assessment

for

Operable Unit No. 2

prepared for

U.S. Department of Energy
Rocky Flats Plant
Golden, Colorado

prepared by

EG&G Rocky Flats, Inc.
Golden, Colorado

May 18, 1993

GENERAL RESPONSES TO COMMENTS

This document presents DOE's responses to comments provided by the Colorado Department of Health (CDH), U.S. Environmental Protection Agency (EPA), and EPA's consultant PRC on Technical Memorandum No. 5, Exposure Scenarios, as part of the Human Health Risk Assessment for OU 2, 903 Pad, Mound, and East Trenches areas at Rocky Flats. General response summaries are presented first, followed by specific responses to individual comments from CDH, EPA, and PRC. More detailed information supporting the DOE positions outlined below is provided in the specific comments.

Response to EPA General Comments

EPA G-1:

Comment: The document states (pg. 2-11) that a number of seeps in OU 2 are "currently being remediated". This is not true.

Response: There is an IM/IRA action going on at several OU 2 seeps.

EPA G-2:

Comment: Numerous statements are made about "future designation as an ecological preserve" (e.g. pg. 2-13). They are speculative, misleading, and largely irrelevant.

Response: While we agree that the full range of currently viable options for future on-site land use should be mentioned, we believe that the referenced text concerning possible establishment of some type of ecological preserve in the buffer zone is appropriate. Certainly the ecological preserve and private industrial park options have received the greatest attention to date and thus would appear to be more likely at this time than residential or agricultural options.

EPA G-3:

Comment: In constructing the Conceptual Site Model (pg. 4-6), the document asserts that there is no contamination in the lower hydro-stratigraphic unit. This conclusion is premature.

Response: LHSU contamination will be addressed in the bedrock program. It is currently assumed that there are no risks posed by LHSU waters. The bedrock program will confirm or deny this premise.

EPA G-4:

Comment: The document repeatedly states that the RFP Surface Water Management Plan was approved by EPA. This plan was not subject to nor did it receive Agency approval.

Response: The RFP Surface Water Management Plan has not been approved by EPA. The text will be changed to show this.

Response to EPA Specific Comments

EPA S-1: Current Off-Site Resident (4.5.2.1)

Comment: The pathways listed on page 4-9 to be evaluated for current off-site residents should also include ingestion of homegrown vegetables and fruits which have been contaminated via uptake of contaminants from soil. The list on page 4-9 includes ingestion of vegetables only which have been contaminated from deposition of particulates. However, both sources of contamination should be evaluated for fruits and vegetables. The rationale provided in the document for not evaluating the uptake source for plants is that metals bind to soil, thus reducing their bioavailability to plants. This is correct, however, reduced bioavailability should not be equated with no bioavailability. Heavy metal uptake into vegetable crops

has been well documented (Boon and Soltanpour 1992). Plant uptake of metals varies depending on factors such as plant type, soil type, soil contaminant concentration, precipitation, etc. Studies have found concentrations of lead ranging up to 1500 ppm in plants, and cadmium ranging up to 35 ppm (Hemphill et al. 1973). This is not an insignificant amount. Hence, both vegetable and fruit uptake of contaminants from soil, as well as deposition of contaminated particulates onto the surface of vegetables and fruits should be evaluated as an exposure pathway to off-site residents.

The pathways on page 4-9 should also include external irradiation from decay of radioactive materials in contaminated soils. As described in Risk Assessment Guidance for Superfund (RAGS), Part A, Chapter 10 (EPA 1989), external radiation exposure is a concern with radionuclides which emit gamma rays (such as Americium and Plutonium), which are the most penetrating of the emitted radiations.

Response: DOE continues to believe that estimating risk due to plant uptake off-site is unreasonable because of the extreme dilution associated with aerial transport and mixing throughout the root zone. Conservative estimates of dilution as a result of Gaussian dispersion to an off-site garden, coupled with tilling of the top 15 cm of the garden soil, result in a dilution factor of at least 60,000 following 30 years of deposition. Dilution due to Gaussian dispersion is estimated to result in an annual deposition rate of less than 100 mg/m^2 of OU 2 particulates on garden soil at the location of the off-site residential receptor. This value is conservative, because the model actually predicts this deposition rate at a distance of one mile from the source. Using a tilling depth of 15 cm and a soil density of 1.2 g/cm^3 results in a total dilution factor of at least 1.8 million for each year's deposition. Assuming that aerially deposited contaminants accumulate at the same rate for a period of 30 years yields a total dilution factor of at least 60,000. Of course, the use of soil amendments would result in further dilution. Therefore, the additive exposure associated with plant

uptake from the soil (compared to deposition of foliar parts) is insignificant.

DOE believes that conceivable concentrations of radioactive materials from OU 2 in off-site areas may represent a relatively significant radiation exposure due to the amount of radiation material present. This pathway will therefore be assessed quantitatively in the risk assessment.

The evaluation of potential exposures to site contaminants via ingestion of fruit will be added to the evaluation of current and hypothetical future residential exposures. The specific values for fruit consumption will be the RME value of 42 grams/day, as recommended in the EPA Standard Default Exposure Factors (OSWER Directive 9285.6-03).

EPA S-2: Future Off-Site Resident (4.5.2.5)

Comment: The pathways listed on page 4-17 for the future off-site resident should include ingestion of homegrown vegetables and fruits which have been contaminated via uptake of contaminants from soil, as well as from deposition of particulates. The reasoning for this is provided in the paragraph above concerning current off-site residents.

The pathways listed on page 4-17 should also include external irradiation from decay of radioactive materials in contaminated soils. The reasoning is also provided in the above section.

Response: DOE continues to believe that estimating risk due to plant uptake off-site is unreasonable because of the extreme dilution associated with aerial transport and mixing throughout the root zone. Conservative estimates of dilution as a result of Gaussian dispersion to an off-site garden, couple with tilling of the top 15 cm of the garden soil, result in a dilution factor of at least 60,000 following 30 years of deposition. Dilution due to Gaussian dispersion is estimated to result in an annual deposition rate of less than 100 mg/m^2 of OU 2 particulates on garden soil at the location

of the off-site residential receptor. This value is conservative, because the model actually predicts this deposition rate at a distance of one mile from the source. Using a tilling depth of 15 cm and a soil density of 1.2 g/cm^3 results in a total dilution factor of at least 1.8 million for each year's deposition. Assuming that aerially deposited contaminants accumulate at the same rate for a period of 30 years yields a total dilution factor of at least 60,000. Of course, the use of soil amendments would result in further dilution. Therefore, the additive exposure associated with plant uptake from the soil (compared to deposition of foliar parts) is insignificant.

DOE believes that conceivable concentrations of radioactive materials from OU 2 in off-site areas may represent a relatively significant radiation exposure due to the amount of radioactive material present. This pathway will therefore be assessed quantitatively in the risk assessment.

The evaluation of potential exposures to site contaminants via ingestion of fruit will be added to the evaluation of current an hypothetical future residential exposures. The specific values for fruit consumption will be the RME value of 42 grams/day, as recommended in the EPA Standard Default Exposure Factors (OSWER Directive 9285.6-03).

EPA S-3: General Exposure Assumptions (5.1.1)

Comment: On page 5.3 the exposure frequency to soil ingestion and inhalation of particulates was changed from 350 days/year to 290 days/year (for residential) and from 250 days/year to 207 days/year (for occupational) because of information on snow cover. If the information were being used to determine whether or not someone actually went on the site because of the weather, such as in a recreational or trespassing scenario, this assumption would be correct. However, since the residents are expected to live in their housing areas, and the workers are expected to come to work regardless of the weather, this assumption is inappropriate. The concept that soil ingestion is limited to outdoor exposure is erroneous.

The EPA soil ingestion value is a combination of outdoor soil and indoor dust which can not be divided evenly throughout the day. Tracer element studies have shown that approximately 50% of soil ingestion is from outdoor soil and approximately 50% is from indoor dust, even though the study participants were outdoors only 1.5 hours/day on the average (Stanek and Calebrese 1992). Unless site-specific information is available on the concentration of contaminants in both outdoor soil and indoor dust, it is assumed that the concentration of contaminants in indoor dust is equal to the concentration in outdoor soil. Therefore, the exposure frequency for ingestion of soil should remain at 350 days for residential and 250 days for occupational receptors.

Response: The current literature regarding the relative contribution of outdoor soil to indoor dust is inconclusive. DOE assumes that, even for individuals who spend all of their time at home, only half of the ingested soil or dust originates as contaminated media. The other half includes dust from more distant sources, as well as a variety of indoor sources unrelated to outdoor soils. Therefore, DOE will use an FI value of 0.5 and an exposure frequency of 350 days/yr (residential) and 250 days/yr (occupational, other than construction).

EPA S-4: Inhalation Assumptions (5.1.2)

Comment: Page 5-4 lists the inhalation exposure frequency for current and future residential receptors as 16 hours/day. This is incorrect. The correct value is 24 hours/day. It is not unreasonable to assume that sensitive members of the receptor population such as infants and elderly people spend the entire day at their housing area.

Page 5-5 is proposing a deposition factor of 25% for inhaled particles. I would recommend that the deposition factor be eliminated, unless appropriate chemical-specific pharmacokinetic evidence can be provided. Although it is recognized that inhaled particles are deposited in different regions of the respiratory system, this preferential deposition is quite

variable depending on particle size, particle diameter, chemical properties of the contaminant, etc. In situations where the use of a deposition factor would be appropriate, such as route-to-route extrapolations based on absorbed doses, information on the exposure conditions and pharmacokinetics of the contaminant should be evaluated carefully before a deposition factor is selected.

It is generally inappropriate, however, to use a deposition factor in a generic equation for estimating exposure. To obtain an estimate of risk, the intake derived from this calculation is compared to a reference concentration (RfC) of slope factor which is, except for a few cases, based on a delivered dose. In other words, the toxicity predicted by the majority of RfC's or slope factors, is directly comparable to a given chemical concentration in the inhalation chamber (or occupational setting). It is not directly comparable to the amount of chemical deposited in the pulmonary region or absorbed into the blood stream.

Response: DOE disagrees with the assumption that RME individuals spend all of their time at their residence every day for 30 years but will use 24 hr/day. DOE will use the CDH recommended value of 75 percent for the percentage of inhaled particles that are deposited in the lung.

EPA S-5: Soil Ingestion Assumptions (5.1.3)

Comment: Technical Memorandum Number 5 proposes to modify soil intake by using a fraction ingested factor and a bioavailability factor on page 5-6. I suggest that both of these factors be removed.

The purpose of the fraction ingested factor is to modify the amount of soil ingested by a receptor, based on the assumption that a person only spends so much time outdoors, and that soil ingestion is limited to outdoor exposure. The concept that soil ingestion is limited to outdoor exposure, and that the EPA soil ingestion value can be evenly divided throughout the day is erroneous. The 100 mg/day soil ingestion value is a

combination of outdoor soil and indoor dust. Tracer element studies have shown that approximately 50% of soil ingestion is from outdoor soil and approximately 50% is from indoor dust, even though the study participants were outdoor only 1.5 hours on the average (Stanek and Calabrese 1992). Hence, the idea that soil ingestion only occurs outdoors and is proportional to the time spent outdoors is incorrect.

The bioavailability factor assumes that contaminants bind tightly to soil and, when ingested, are not available for absorption across the G.I. tract into the bloodstream. Bioavailability of contaminants from soil in the G.I. tract is an unresolved issue. Not only is bioavailability chemical-specific, but the scientific literature to date suggests that the bioavailability of the few chemicals actually studied is highly variable. Bioavailability is affected not only by the chemical present, but the chemical species, particle size, chemical concentration, soil morphology, and physiological status of the receptor (stomach pH, nutritional status, time between meals, etc.). Perhaps the most extensively studied chemical in terms of bioavailability is lead. A number of animal bioavailability studies using different forms of soil and lead species have been conducted with resulting bioavailabilities ranging from 5 - 40%. Even for a chemical as well studied as lead, it is difficult to recommend a bioavailability factor. Region 8 has, however, used reduced bioavailability factors for contaminants based on site-specific geochemical and geophysical characterization of the chemical form present in the soil and in vivo bioavailability studies in animals. If DOE can provide this type of site-specific data, we will consider the sue of a reduced bioavailability factor. However, until DOE provides this evidence or until further research is conducted in this area, it would be extremely difficult to recommend a factor for bioavailability from soil at this time.

Response: The current literature regarding the relative contribution of outdoor soil to indoor dust is inconclusive. DOE assumes that, even for individuals who spend all of their time at home, only half of the ingested soil or dust originates as contaminated media. The other half includes dust from more

distant sources, as well as a variety of indoor sources unrelated to outdoor soils. Therefore, DOE will use an FI value of 0.5.

For some compounds, the ability of soils to bind the chemical can be significant, especially in its effects on the availability of the compound for dermal exposures. Chemical-specific information regarding the ability of soil to bind compounds so as to reduce their availability for human exposure will be submitted to CDH and EPA for review and approval as part of the toxicity technical memorandum.

EPA S-6: Homegrown Produce Ingestion Assumptions (5.1.4)

Comment: For each pathway where ingestion of homegrown produce is a concern, both fruits and vegetables should be evaluated, and contamination from uptake as well as deposition should be assumed. The reasons for this have been provided above.

Page 5-7 states that 80,000 mg/day is the daily RME intake rate for vegetables. This is correct, however, fruit can also be considered as "homegrown produce". The daily RME intake rate for homegrown fruit is 42,000 mg/day (EPA 1991a).

Page 5-7 proposes the use of a matrix effect of produce on this bioavailability of ingested contaminants from that produce. This assumption should be removed. Contaminants which are deposited on the surface of produce are not "bound" to the produce. Most of these contaminants can be readily washed off of the produce with water. However, one should not make the assumption that people always wash their produce, because they don't. Therefore, it is reasonable to assume that the contaminants on the surface of the produce are readily available for absorption from the G.I. tract. It's plausible to assume that contaminants which have been taken up from the soil into the plant, are not as readily available for absorption as are contaminants deposited on the surface of the produce. However, the available information on this

phenomena is even more scarce than that on the bioavailability of contaminants from soil. Until further research is conducted in this area, it would be extremely difficult to recommend a factor for bioavailability from produce.

Response: DOE continues to believe that estimating risk due to plant uptake off site is unreasonable because of the extreme dilution associated with aerial transport and mixing throughout the root zone. Conservative estimates of dilution as a result of Gaussian dispersion to an off-site garden, couple with tilling of the top 15 cm of the garden soil, result in a dilution factor of at least 60,000 following 30 years of deposition. Dilution due to Gaussian dispersion is estimated to result in an annual deposition rate of less than 100 mg/m^2 of OU 2 particulates on garden soil at the location of the off-site residential receptor. This value is conservative, because the model actually predicts this deposition rate at a distance of one mile from the source. Using a tilling depth of 15 cm and a soil density of 1.2 g/cm^3 results in a total dilution factor of at least 1.8 million for each year's deposition. Assuming that aerially deposited contaminants accumulate at the same rate for a period of 30 years yields a total dilution factor of at least 60,000. Of course, the use of soil amendments would result in further dilution. Therefore, the additive exposure associated with plant uptake from the soil (compared to deposition of foliar parts) is insignificant.

The evaluation of potential exposures to site contaminants via ingestion of fruit will be added to the evaluation of current an hypothetical future residential exposures. The specific values for fruit consumption will be the RME value of 42 grams/day, as recommended in the EPA Standard Default Exposure Factors (OSWER Directive 9285.6-03).

A bioavailability value will not be used to estimate human absorption of contaminants taken up into plants. It is anticipated that much of the exposure to site-related contaminants via ingestion of home-grown produce will be the result of the aerial deposition of soils onto the surfaces of

plants. Therefore, DOE will assume that the bioavailability of contaminants in soil will also apply to contaminants in resuspended soil deposited on plants.

Realistically, however, any individual who eats vegetables and fruits will certainly wash them first. DOE believes that the use of very conservative assumptions concerning the proportion of produce provided by the residential garden is reasonable only if it is also assumed that the resident washes the produce prior to consumption. The assessment will therefore include an evaluation of the amount of soil-bound contaminants that would be expected to be washed off the produce prior to consumption. DOE will apply a soil washoff factor for the on-site and off-site residential garden scenarios.

EPA S-7: Dermal Contact with Soil (5.1.6)

Comment: Page 5-8 states that dermal uptake of metals is negligible and is not addressed in human health risk assessments. The second part of this statement is incorrect and does not accurately reflect the text which it references. Dermal uptake of metals is oftentimes insignificant in relation to other pathways of exposure, however EPA will generally address it either in a quantitative or qualitative manner depending on the region and the site-specific circumstances. This statement should be corrected. Region 8's policy has been to address dermal exposure to metals in a qualitative manner in a human health risk assessment.

Page 5-8 assumes an RME surface area of 2,910 cm^2/day for dermal contact with soil for both the residential and occupational receptors. This is incorrect. EPA's Dermal Exposure Assessment: Principles and Applications (EPA 1992a) and Interim Dermal Risk Assessment Guidance (EPA 1992b) suggest that a typical or average surface area for dermal exposure to soil (head and hands only, individual wears a long-sleeved shirt and pants) is 2,000 cm^2 and a reasonable upper value (head, hands, forearms, and lower legs, individual wears a short-sleeved shirt and shorts)

is 5,300 cm^2. Although an occupational worker on the site may wear a long-sleeved shirt and pants at all times, this is not a reasonable assumption to make for a residential receptor. Both of these values can be explored in the risk assessment, however, to be consistent with the RME concept, the value of 5,300 cm^2 should be used.

Page 5-9 proposes to calculate an absorbed fraction for dermal exposure based on data available in the scientific literature. EPA's Dermal Exposure Assessment: Principles and Applications (EPA 1992a) provides suggested values for the dermal absorption fraction of several chemicals/classes of chemicals, as well as guidance on calculating an absorbed fraction for chemicals for which no experimental dermal absorption data from soil is available.

Page 5-9 proposes to use a soil adherence factor of 0.5 mg/cm^2. Both of the dermal guidance documents listed above (EPA 1992a, 1992b) recommend a central tendency value for soil adherence of 0.2 mg/cm^2 and an upper value of 1.0 mg/cm^2. To be consistent with the RME concept, the value of 1.0 mg/cm^2 should be used in the risk calculation.

Page 5-9 proposed to use a modifying factor for the fraction of soil contacted. You should be aware that this parameter is not part of the dermal exposure equation provided in RAGS: Part A (EPA 1989) or the Interim Dermal Risk Assessment Guidance (EPA 1992b). This factor erroneously assumes that (1) dermal exposure occurs via outdoor soil only and not via indoor dust (similar to the assumption made for the soil ingestion fraction above), and (2) dermal exposure to soil occurs only when you are outdoors (i.e., the soil disappears from your skin when you come indoors). For these reasons, this factor should be removed from the calculation.

Response: DOE will address dermal exposure to metals in a qualitative manner in the risk assessment.

The derivation of the specific value of 5,800 cm^2 suggested in this comment is unknown. Based on information presented in the EPA's Exposure Factors handbook, a typical exposure case (i.e., individual wears long sleeve shirt, pants and shoes) the exposed skin surface is estimated to be 2,000 cm^2. The most recent guidance in the Interim Guidance for Dermal Exposure Assessment recommends use of the upper end of the range for exposed skin area as 5,000 cm^2 for adults (hands, legs, arms, neck, and head). Because the residential exposure scenario is intended to characterize average exposures over all seasons, this recommended default value of 5,000 cm^2 is conservative for evaluating this exposure scenario. Since a "typical case" exposure is defined to be limited to 2,000 cm^2, DOE believes that assessing the ecological researcher's exposure at 2,910 cm^2 is adequately protective.

When providing risk estimates for a hazardous waste site, the objectives and guidelines provided by EPA are to define a conservative but reasonable estimate, usually the 95th percentile of maximum probable risk. (See EPA 1991b, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors." OSWER Directive 9285.6-03, Page 2.) (Also see Federal Register, Volume 57, Number 104, Page 22922, Friday, May 29, 1992.) Because the derivation of the risk estimates are a combination of many different individual assumptions, the use of the most conservative value for each assumption may lead to an estimate of exposure (and risk) that is unreasonable and far above the 95th percentile. Compounding extreme conservatism can result in a total exposure that is unrealistic and can inappropriately influence the establishment of cleanup criteria and evaluation of remediation alternatives. DOE believes that the scenarios described in this technical memorandum, as revised, are amply conservative and consistent with EPA guidelines. Therefore, an average soil adherence factor of 0.5 mg/m^3 will be used.

DOE plans to evaluate dermal absorption of compounds on a chemical-specific basis, with specific values determined from appropriate, current literature. This information will be submitted for review and approval in the Toxicity Assessment Technical Memorandum. EPA and CDH will have an opportunity to review the methodology and specific values to be used at the time.

The current literature regarding the relative contribution of outdoor soil to indoor dust is inconclusive. DOE assumes that, even for individuals who spend all of their time at home, only half of the ingested soil or dust originates as contaminated media. The other half includes dust from more distant sources, as well as a variety of indoor sources unrelated to outdoor soils. Therefore, DOE will use an FI value of 0.5.

EPA S-8: Dermal Contact with Surface Water (5.1.7)

Comment: The document proposes a water permeability constant of 8.0 E-04 cm/hour. The Interim Dermal Risk Assessment Guidance (EPA 1992b) provides permeability constants for 200 common organics in water and 13 inorganics. I suggest that these chemical-specific values be used instead of a generic default value.

Response: Chemical-specific permeability constants, if available, will be determined from appropriate, current literature. This information will be submitted for review and approval in the Toxicity Assessment Technical Memorandum. EPA and CDH will have an opportunity to review the methodology and specific values to be used at the time.

EPA S-9: External Irradiation (5.1.9)

Comment: This section proposes to estimate exposure from external irradiation from a method described in EPA's RAGS: Part A (EPA 1989) which is difficult to follow. A somewhat less confusing method is described in EPA RAGS: Part B (EPA 1991b) and may be easier to use.

Response: The methodology proposed in RAGS: Part B is different from that proposed in Section 5.1.9 and does not use site-specific intake factors. Our proposed methodology is adaptive to site-specific conditions.

EPA S-10: Tables 5-2 - 5-30

Comment: The tables in this section should be revised appropriately to reflect the comments above.

Response: The tables in Section 5 will be revised to reflect responses.

Response to PRC General Comments

PRC G-1:

Comment: The intent of this document is to identify and characterize potential and reasonable maximum exposure scenarios for present and future human receptors in OU 2 and present reasonable maximum intake parameters which will be used to estimate chemical intake. Although it comprehensively identifies exposure scenarios, the intake parameters presented in most of the scenarios fall short of reasonable maximum value conventionally used for Superfund sites. The parameters should be revised to reflect a more conservative approach.

Response: When providing risk estimates for a hazardous waste site, the objectives and guidelines provided by EPA are to define a conservative but reasonable estimate, usually the 95th percentile of maximum probable risk. (See EPA 1991b, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors." OSWER Directive 9285.6-03, Page 2.) (Also see Federal Register, Volume 57, Number 104, Page 22922, Friday, May 29, 1992.) Because the derivation of the risk estimates are a combination of many different individual assumptions, the use of the most conservative value for each assumption may lead to an estimate of exposure (and risk) that is unreasonable and far above the 95th percentile. Compounding extreme conservatism can result in a total exposure that is unrealistic and can inappropriately influence the establishment of cleanup criteria and evaluation of remediation alternatives. DOE believes that the scenarios described in this technical memorandum, as revised, are amply conservative and consistent with EPA guidelines.

After the various exposure factors are agreed upon, they will be used to calculate a single, site-specific RME for each exposure scenario.

PRC G-2:

Comment: The document asserts that future development of off-site land will be mainly industrial, which is not supported by information presented in the document. While a future off-site residential scenario is considered in the risk assessment, this assertion is misleading and conflicts with tables presented in Section 3.0 which reflect nearly a three-fold population increase in the regions surrounding RFP. The text should be revised to present a more accurate discussion of future off-site land use.

Response: The last paragraph of Section 3.2.2 which asserts future industrial development will be deleted. The following information will be added:

Future land use east, southeast, and south of RFP is expected to consist mostly of open space and commercial/industrial, with smaller areas of mixed commercial/rural residential. Suburban residential developments are expected to occur farther east, probably at least 2 miles from RFP. The timing for transition of some existing agricultural lands to open space is not known.

DOE believes that the receptors selected, and especially those retained for quantitative evaluation, are conservative and protective of human health.

Response to PRC Specific Comments

PRC S-1: Page 4-4, Second Paragraph.

Comment: The text states that "Dermal contact with soil will only be assessed quantitatively if sampling results from the OU 2 Phase II Investigation demonstrate the presence of organic chemicals of concern in surface soil samples at concentrations exceeding background." This approach is inappropriate for three reasons (EPA 1989a). First, all chemicals of concern (COCs) should be evaluated for every "applicable" exposure

pathway. Second, unlike inorganic chemicals which are naturally present, all "organic" chemicals should be considered to be anthropogenic. Thus, there are no background concentrations which COCs can be compared to. Third, if organic chemicals are detected in background samples, the selection of the background area will be in question because it indicates the area was impacted by RFP activities.

Rationale: All COCs should be evaluated for all exposure pathways. Organic chemicals should be considered anthropogenic can not be compared to background samples.

Response: Risks will be characterized for all exposure to chemicals selected as chemicals of concern of OU 2. However, not all pathways will be evaluated quantitatively. For example, it is commonly recognized in Region 8 that metals do not translocate across skin; thus, this pathway is not evaluated quantitatively in a risk assessment. Specific information regarding dermal absorption of chemicals will be submitted to CDH and EPA for review and approval prior to inclusion in the Toxicity Assessment Technical Memorandum. Organics in background samples will be evaluated so that only contamination specifically related to OU 2 is assessed.

PRC S-2: Pages 4-15 through 4-17, Section 4.5.2.5.

Comment: Groundwater ingestion has not been considered for the future off-site residential scenario. If groundwater modeling results indicate that off-site residents are downgradient, then this pathway should be evaluated as part of a reasonable maximum exposure scenario.

Rationale: All potential and reasonable maximum scenarios should be evaluated.

Response: Groundwater ingestion is an incomplete exposure pathway for off-site residents. UHSU groundwater either discharges to surface water or is lost

to evapotranspiration. Groundwater in the LHSU will be assessed during the bedrock program.

PRC S-3: Page 5-10, Section 5.1.8, First Paragraph.

Comment: The document states that intake of radionuclides will be calculated and compared to radiation protection standards. This comparison is unnecessary for a human health risk assessment prepared for a Superfund site. The goal of a human health risk assessment is to determine baseline health risks and evaluate public health hazards at a site, which provide a basis for determining remedial activities that will be protective of public health. Radiation protection standards are designed to protect adult, healthy male workers in an occupational setting, with control measures in place to closely monitor and limit exposure. They are not meant to be protective of sensitive receptors in a population, who could be exposed to radiation without limits and control measures in place.

Rationale: A comparison of radionuclide intake to radiation protection standards is not necessary and does not follow EPA guidance for a human health risk assessment.

Response: It is also stated in the same paragraph that:

> The second method for evaluation of internal radionuclide exposure will be conducted by calculating the intake of radionuclides and multiplying that intake by EPA-derived carcinogenic slope factors for each radionuclide of concern (EPA 1989a). The result of this calculation will be the unitless carcinogenic risk associated with ingestion or inhalation of a given radionuclide of concern.
>
> DOE will look at radiation protection standards per RAGS, Part A, Chapter 10 (EPA 1989).

PRC S-4: Table 5-11.

Comment: Averaging times for construction workers should be 365 days (EPA 1989b). The table lists 30 days. The table should be corrected.

Rationale: The table should reflect generally accepted exposure parameters.

Response: Table 5-11 will be corrected.

Response to CDH General Comments

CDH G-1:

Comment: The major problem with this TM is the use of fractional intakes and other techniques to "fine-tune" exposure estimates. In general, most of these fine-tuning procedures are not acceptable because they are not consistent with the baseline risk assessment recommendation that RME estimates be used. Thus the proposed methods for calculating intakes will not provide a sufficiently conservative estimate of the extent of risk. Moreover, the Division specifically stated in our review of the first draft of this TM and in the reviews of the baseline risk assessment for OU 1 that the use of fractional intakes was not appropriate and that these factors should not be used. DOE agreed in the baseline risk assessment for OU 1 and should, therefore, carry this over into OU 2.

Response: When providing risk estimates for a hazardous waste site, the objectives and guidelines provided by EPA are to define a conservative but reasonable estimate, usually the 95th percentile of maximum probable risk. (See EPA 1991b, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors." OSWER Directive 9285.6-03, Page 2.) (Also see Federal Register, Volume 57, Number 104, Page 22922, Friday, May 29, 1992.) Because the derivation of the risk estimates are a combination of many different individual assumptions, the use of the most conservative value for each assumption may lead to an estimate of exposure (and risk) that is unreasonable and far above the 95th percentile. Compounding extreme conservatism can result in a total exposure that is unrealistic and can inappropriately influence the establishment of cleanup criteria and evaluation of remediation alternatives. DOE believes that the scenarios described in this technical memorandum, as revised, are amply conservative and consistent with EPA guidelines.

After the various exposure factors are agreed upon, they will be used to calculate a single, site-specific RME for each exposure scenario.

CDH G-2:

Comment: Related to the previous comment, we expect that all procedures within the risk assessment amenable to standardization be made consistent between OUs. This would include such things as exposure scenarios and sub-scenarios considered, receptor intake variable values and calculations, etc. This includes, and should be accomplished for, OU 2.

Response: DOE has instituted information exchanges between OU 1, 2, 3, 4, 5, 6, and 7 project teams. This will assure consistency to the extent practicable, but OU-specific conditions must be taken into account.

CDH G-3:

Comment: The exposure scenarios presented in this TM consistently avoid inclusion of the more sensitive populations, especially children. Values for the exposure and intake parameters for children must be considered and the methodology for including the parameters should be clearly presented.

Response: Except for the ingestion of soil, for which intake during childhood is significantly higher than for adults, DOE does not believe that it is appropriate to evaluate children as a separate receptor subpopulation. The basis for this determination include (1) the lack of specific guidance on calculating child intake and risks, (2) the lack of benchmark toxicity values for characterizing risks associated with subchronic exposures, and (3) the possibility that the available benchmark inhalation toxicity values (RfCs) already incorporate an adjustment to protect for childhood intakes.

Responses to CDH Specific Comments

CDH S-1: Section 2.2

Comment: The text states that, "more detailed information, such as depths of contamination and the extent of soil removal at the 903 Lip Site, can be found in the Phase II RFI/RI Work Plan". This information should be at least summarized in the Technical Memorandum and in the PHE.

Response: DOE believes that this information is best presented in complete form. A more specific reference will be provided in the revised document.

CDH S-2: Section 2.3

Comment: Page 2-7. The text states, "Wind flows from the west-southwest approximately 7.2% of the year". This figure differs from that used in the OU 1 PHE. Moreover, the wind rose in Figure 2-3 differs from that used in the OU 1 PHE for supposedly the same year. Please clarify this discrepancy.

Response: The wind rose in Figure 2-3 represents 1990 average wind conditions and is from the RFP Health and Safety Program Plan (EG&G 1990) and the 1990 Site Environmental Report (EG&G 1991).

CDH S-3: Section 2.5.4

Comment: Please cite of include the evidence that "the thin, discontinuous character of these sandstones suggest that a hydraulic connection to the alluvium along Woman Creek is unlikely". The State must be able to independently review and evaluate this data before it can accept this statement as justification for the assumption that wells west of Standley Lake could not become contaminated from groundwater originating in Woman Creek or its sediments. Also, please include or cite the data suggesting that "there

are indications that the off-site wells may be hydraulically connected to Standley Lake, a large source of potential recharge".

Response: The Draft Final Technical Memorandum No. 8, Revised Phase II RFI/RI Work Plan (Bedrock) (U.S. DOE 1993) presents the existing lower hydrostratigraphic unit data which supports this statement.

To date, we know of no documented study regarding Standley Lake as a recharge versus discharge point. However, a coarse conglomerate outcrops at Standley Lake; therefore, the potential exists for Standley Lake to be a large source of potential recharge. See the Public Health Risk Assessment for OU 1, Technical Memorandum Number 6, Revision 3.0.

CDH S-4: Section 2.6

Comment: Please state how it was determined that, "No vegetative stresses attributable to hazardous waste contamination have been identified". What measurements were taken? What other types of stressors have been identified?

Response: The source of this information is from the reviewed and approved Phase III RFI/RI Work Plan for OU 1, March (EG&G 1991).

CDH S-5: Section 3.0

Comment: The reference cited throughout this section of the TM, DOE 1990, uses 1980 census data. Census data for 1990 has been available for some time and should be incorporated in all RFP documents, including this one.

Response: Many comments criticize the use of the DOE (1990) document, titled *1989 Population, Economic, and Land Use Data for Rocky Flats Plant*. The primary objection appears to be that the use of that report, much of which is derived from 1980 census data, results in reliance on outdated for incorrect data. Actually, many of the projections described in DOE (1990)

are based on actual rather than projected demographic information, such as population growth rates and, in some cases, revised population estimates. It is therefore incorrect to characterize the data presented in the technical memorandum as being based on outdated information. The 1989 (DOE 1990) document was used for consistency with other risk assessments at RFP. More importantly, it should be remembered that the DOE (1990) was used only as a basis for qualitatively evaluating potential land use scenarios and exposure receptors. Regardless of the accuracy or inaccuracy of data derived from DOE (1990), DOE believes that the receptors selected, and especially those retained for quantitative evaluation, are conservative and protective of human health.

DOE will continue to reference the 1989 document but will use more recent demographic information where appropriate in preparing the revised technical memorandum. After review and approval by EPA and CDH of similar revisions in the technical memorandum for OU 3, data from OU 3 will be reviewed for impact on the OU 2 document.

The effort required to research and incorporate the 1990 census data is not justified for this technical memorandum, given the fact that the data are not used as a basis for quantitative exposure calculations or as a basis of eliminating potential exposure scenarios.

CDH S-6: Section 3.1

Comment: Again, using a 1989 population projection from 1980 data is not acceptable. In addition, the estimate of zero population growth in the area immediately adjacent to the plant boundary is highly suspect given the change in plant mission.

A map should be provided showing the locations of the schools, hospitals and nursing homes within a 10-mile radius of RFP.

Response: Recent land use surveys conducted for OU 3 also indicate a preponderance of open space and commercial/industrial land uses adjacent to RFP in the downwind direction. The revised technical memorandum will address the anticipated residential growth in the areas between Indiana Street and Standley Reservoir and each of Great Western Reservoir. Both of these areas will be conservatively represented by hypothetical residential receptors at the RFP fenceline in the predominant downwind direction (east-southeast) along Woman Creek and at the closest off-site location along Walnut Creek.

Development and inclusion of such a map would not add to the technical memorandum. Future on-site and off-site receptors depicted in Figure 3-7 have been selected as being appropriate and conservative.

CDH S-7: Section 3.2.1

Comment: The second sentence on the top of page 3-3 should be changed to read "The northeastern Jefferson County and RFP includes one of the most..."

Response: The meaning of the sentence is more accurately reflected by the present language than the suggested revision. However, we would agree that the sentence may over-emphasize the present or expected future extent of industrialization in the area surrounding RFP, and we will therefore delete it.

CDH S-8: Section 3.2.2

Comment: Industrial land-use will probably not "dominate" future land-use in northeastern Jefferson county, particularly given the plant mission change and the pace of residential development in the area.

Reference to Highway W-470 is obsolete since this project is currently defunct.

The second complete paragraph on page 3-4 does not accurately represent the facts. W-470 is no longer an issue, only a small percentage of the area is industrial, zoning does not allow for "heavy" industrial, and the plant's mission has changed.

The third paragraph on page 3-4 uses outdated information from the same report (DOE 1990) mentioned earlier. Mission change and community perceptions have changed.

The last paragraph in this section is also inaccurate. Current land use in the immediate vicinity of RFP is not primarily commercial/industrial. It is predominantly low density agricultural and residential which can be seen from DOE's inclusion of the land use map and Table 3-2 in this document.

Response: The paragraph accurately summarizes what was projected by Jefferson County in their 1989 document and thus is correct as written. However, we agree that recent changes in the mission of RFP may result in changes in the pattern and prevalence of land use. Other activities that may affect future land use will also be discussed. Examples include possible developments such as the Jefferson Center, W-470, Jefferson County Airport expansion, and Tucker Lake Golf Course expansion and their potential influence on future land use in the area east of RFP.

Although W-470 is currently "dead," the continued growth in northeastern Jefferson County and southeastern Boulder County correctly noted in an earlier CDH comment make its resurrection possible.

We do not see anything in the referenced paragraph that would be affected by more recent census data, except perhaps for the number of people serviced by the City of Broomfield's water treatment plant east of Great Western Reservoir. We will verify the number and revise it if appropriate. We will revise the text as follows, beginning halfway through the first sentence:

Future land use east, southeast, and south of RFP is expected to consist mostly of open space and commercial/industrial, with smaller areas of mixed commercial/rural residential. Suburban residential developments are expected to occur farther east, probably at least 2 miles from RFP. The timing for transition of some existing agricultural lands to open space is not known.

The last paragraph in Section 3.2.2 will be deleted.

CDH S-9: Section 3.3.2

Comment: On page 3-6, the text states that occupation by private industry is planned for future use of the on-site production areas. This issue should be revisited in light potential changes brought about by the new administration and Energy Secretary. Also, there are many inherent problems with private industry using portions of RFP that DOE has been unable to coherently address at this time.

The Rocky Flats Local Impacts Initiative (RFLII) is not "working to achieve" private industry use of RFP. They are evaluating this as one option to minimize economic impacts to the surrounding communities from the changing plant mission.

It is clear that the authors of this section of the text need to receive clarification on these issues from knowledgeable DOE sources. This information should not be coming from the cited sources (Denver Post, Boulder Daily Camera, RFLII).

The first paragraph on page 3-7 states that the buffer zone is being considered as a potential ecological preserve. What the text does not state, but needs to, is that this is only one of several potential uses under consideration. In light of the mission change, many more land use options have become viable.

At the bottom of page 3-7 the text states that extensive development of the area is unlikely. Again, mission change has made this statement less certain.

The last paragraph of this section is entirely wrong for the previously stated reasons.

Response: The text will be modified to present the range of future land use options currently being discussed for RFP. Furthermore, the preceding text in this section, which references DOE (1980) and DOE (1992), will be rewritten as historical background and to reflect that the fourth bullet at the top of page 3-17 (Alternative 3) has proven to be the correct scenario. However, we believe that it is appropriate to describe DOE's former position relative to use of portions of the RFP industrial area by private industry, as expressed by Admiral Watkins, because the present Secretary has not yet expressed a different position.

The last sentence of this paragraph will be deleted.

This last paragraph of this section will be deleted.

CDH S-10: Section 3.4

Comment: Future on-site residential uses are <u>not</u> inconsistent with planned off-site industrial and commercial development. The RFP buffer zone is very large and could easily allow both residential and industrial/commercial land-uses to co-exist. Residential developments are the predominant land-use off site and are increasingly encroaching on the immediate borders of the buffer zone. The Standley Lake-Louisville-Superior residential area is one of the fastest growing portions of the Denver-Metro area. Water resources are presently not a limiting factor for development and are not anticipated to be in the future. Given the change in plant mission, future on-site residential developments are not longer "improbable". Whether

residential land-use is consistent with outdated DOE plans is no longer relevant.

Response: On-site residential is considered improbable because of the increasing public interest in preserving unplowed prairie and wetland habitats and protecting wildlife. This is evidenced by ongoing acquisition of open space by Jefferson County, Boulder County, and the City of Boulder (including large tracts near RFP) and the recent designation of the Rocky Mountain arsenal as a wildlife refuge by the U.S. Fish and Wildlife Service. Like RFP, the Arsenal is a large (27-square mile) RCRA/CERCLA site that was protected from grazing or development because of weapons production and the need for an extensive buffer zone.

CDH S-11: Section 3.4

Comment: The text states "EPA guidance does not require an exhaustive assessment of every potential receptor and exposure scenario". This may be true, however all potential receptors must be identified and compared to determine the likelihood of harm.

Response: The purpose of evaluating the likelihood of specific land use (and thus exposure) scenarios occurring on site or off site in the future is to provide the risk manager and others reading or using the risk assessment with realistic information on potential overall impacts. It is not an attempt to avoid performing a quantitative assessment for any given scenario. Moreover, DOE believes that the scenarios retained for quantitative assessment are both reasonable and conservative, and that the approach used is consistent with recent EPA guidance (Habicht, H.F. II, 1992, Memorandum to Assistant and Regional Administrators: Guidance on Risk Characterization for Risk Managers and Risk Assessors. February 26).

The text will be revised to read as follows:

> Current and future human population groups on and near the site are potential candidates for evaluation based on their likelihood of exposure to site-related chemicals of concern. EPA guidance does not require an exhaustive assessment of every potential receptor and exposure scenario (EPA 1992a). Rather, the highest potential exposures that are reasonably expected to occur (reasonable maximum exposures) should be evaluated along with an assessment of any associated uncertainty (EPA 1989a). However, all potential receptors will be identified and evaluated to determine if important exposure pathways or receptors have been overlooked.

CDH S-12: Section 3.5.2

Comment: Simply because current workers are monitored and protected by current health and safety programs does not mean that current environmental or construction worker scenarios should not be evaluated. In addition, in the Division's comments to the first draft of TM 5, we requested that dermal contact with surface water and sediment and inadvertent ingestion of surface water and sediment be evaluated. DOE still has not included these pathways.

Construction workers are exposed to subsoil. Possible health risks from that media need to be evaluated.

Please clarify the location for the future on-site construction worker receptor. Are IHSS's considered for this exposure scenario?

The future on-site ecological researcher scenario should consider exposure at or within the IHSS's. In a baseline risk assessment, it is inappropriate to assume a future institutional control like a fence. Exposure of this receptor to the IHSS's must be included.

Response: There appears to be some confusion concerning the use of health and safety data in the risk assessment. A risk estimate will be provided for the current on-site worker (security guard) based on reasonable, conservative assumptions. The reason for including health and safety information is to support the comparison of potential exposure-point concentrations with those in an industrial setting. Exposure and risk estimates will be calculated in the risk assessment, and exposure estimates will be compared to current Occupational Safety and Health Administration (OSHA) guidelines for informational purposes only. (See second paragraph on page 3-12.)

DOE believes that the current RFP workers that spend the greatest amount of time in OU 2 are plant security personnel conducting routine security patrols. The guards would not have contact with surface water or sediments due to their behavior and protective clothing.

The last sentence of the 2nd paragraph on page 3-13 states that exposure of future construction workers to excavated soils will be evaluated in the risk assessment.

The location for the future on-site construction could be anywhere in OU 2.

The concentration of contaminants in IHSSs will be taken into account when assessing the ecological researcher scenario. No future institutional controls will be used when assessing any future use scenarios.

CDH S-13: Table 3-1

Comment: This table should be updated to reflect 1990 census data.

Response: The effort required to research and incorporate the 1990 census data is not justified for this technical memorandum, given the fact that the data

are not used as a basis for quantitative exposure calculations or as a basis of eliminating potential exposure scenarios.

CDH S-14: Table 3-2

Comment: Please provide a definition for the zoning code "M-C".

Response: M-C is defined as "mineral-conservation."

CDH S-15: Table 3-4

Comment: Current agricultural use occurs off site and is considered "plausible" in the future. Why hasn't an off-site agricultural family scenario been quantitatively evaluated? Assumptions made under the worker or residential scenarios may not apply to people who live on agricultural property because of differences in length of workday, seasonal changes in work habits, etc. Guidance for exposure parameters to use when considering this scenario are in EPA, 1991 (OSWER Directive 9285.6-03).

Response: On-site agriculture is considered improbable because of the increasing public interest in preserving unplowed prairie an wetland habitats and protecting wildlife. This is evidenced by ongoing acquisition of open space by Jefferson County, Boulder County, the City of Boulder (including large tracts near RFP) and the recent designation of the Rocky Mountain Arsenal as a wildlife refuge by the U.S. Fish and Wildlife Service. Like RFP, the Arsenal is a large (27-square mile) RCRA/CERCLA site that was protected from grazing or development because of weapons production and the need for an extensive buffer zone. Additionally, agriculture would offer poor economics compared to commercial/ industrial development.

Off-site agriculture is considered to be less likely than residential, commercial/industrial, or recreational uses because of economics as well as increasing public and community interest in preserving open space.

This is also consistent with existing regional zoning and land use designations, as discussed in Section 3.2 of the technical memorandum and shown in the figures included in that section. Therefore, although agriculture currently occurs in nearby off-site areas, it is anticipated that this use will gradually diminish and eventually disappear from parcels closest to the site.

CDH S-16: Figure 3-1

Comment: This figure should be updated to reflect 1990 census data.

Response: The effort required to research and incorporate the 1990 census data is not justified for this technical memorandum, given the fact that the data are not used as a basis for quantitative exposure calculations or as a basis of eliminating potential exposure scenarios (see response to General Comment I). Therefore, this figure will be retained for consistency with other risk assessments performed for RFP.

CDH S-17: Figure 3-3

Comment: This map is not readable.

Response: An improved version of Figure 3-3 will be included in the revised document.

CDH S-18: Figure 3-7

Comment: The exposure point for future off-site residents should be moved south until it is located on the predominant wind vector emanating from the relatively small area containing the OU 2 IHSS's.

Response: The future off-site residential exposure point at the intersection of Indiana Avenue and Woman Creek is west-northwest of the OU 2 IHSS area in the predominant downwind direction.

CDH S-19: Section 4.2

Comment: This section should include a discussion of potential exposures to other media, i.e., airborne soil, direct soil and sediment contact, etc. as well as to ground and surface water.

Response: This paragraph was misplaced in the document. It belongs in the current and future land use discussions in Section 3.

CDH S-20: Section 4.3

Comment: Please clarify the receptor locations for the current on-site occupational receptor and the future on-site resident. Also clarify the meaning of "on-site, within the OU 2 area" in terms of how the OU 2 data will be interpreted. The Division strongly feels that data sampled from IHSS's must be considered separately. The way DOE presented the data from the IHSS's on OU 1 separately from the rest of the OU provides a good picture of the extent of contamination, and this procedure should be used on all OUs for all appropriate receptors.

Response: The current on-site worker (guard) patrols all of OU 2 routinely. If on-site residential development did occur in the future (improbable future land use), the resident could be located anywhere within OU 2.

CDH S-21: Section 4.4

Comment: Subsurface soil exposures and dermal contact with sediment also should be included in the list of exposure pathways.

Response: Comment noted.

CDH S-22: Section 4.5.1

Comment: The lower hydrostratigraphic unit (LHSU) has not been completely characterized. Nevertheless, some levels of contamination have been found. The Division does not believe it is appropriate to call ground water ingestion and dermal contact with LHSU water an incomplete pathway at this time.

Construction workers in a confined space could conceivable be exposed to VOCs. Moreover, they also could be exposed to high concentrations of outdoor VOCs when freshly uncovering contaminated subsoil. Diffusion in air would likely dilute some of these VOCs, but the amount of dilution would depend upon the concentration of VOCs exposed, the windspeed, the humidity, and a number of other factors. Moreover, depending on these factors, the dilution is not likely to be instantaneous. Therefore, DOE has not convinced the Division that high concentrations of VOCs could not be encountered, and we recommend that exposure of construction workers to outdoor VOCs be quantified.

Response: Contamination of the LHSU will be addressed in the bedrock program. Exposure pathways will be evaluated based on LHSU sampling results.

Exposure to VOCs in subsurface soils would be subject to a high dilution from construction activities as well as from being open to the air. This dilution is expected to be large enough that exposures from incidental ingestion of soil as well as dermal contact with soil is much more significant.

CDH S-23: Section 4.5.2.1

Comment: The Division must be able to review and independently evaluate the off-site sediment sampling data that indicates that incidental ingestion of, and dermal contact with, off-site sediments would be incomplete pathways.

The Division does not agree with the statement that, "the primary radionuclides of concern at the RFP, plutonium and americium, do not have highly penetrating radiation associated with them". These two radionuclides emit not only alpha particles, but also emit beta and gamma radiation. The Division also cannot agree *a priori* that "external irradiation exposures to off-site residents resulting from deposition of radionuclides via airborne particulates are expected to be an incomplete pathway since relatively low concentrations of radionuclides in off-site residential soils due to fugitive dust deposition are expected". The surface soil sampling data that shows this must be reviewed first.

The State does not consider the rationale presented by DOE for only evaluating surface deposition of particulates on plants potentially consumed by off-site residents to be valid. The uptake by fruits and vegetables of contaminants from soil must be considered as well.

- The fact that "metals bind tightly to soil, thus greatly reducing their bioavailability to plants" is true. However, it is well known that a wide variety of plants can concentrate metals, even against concentration gradients. Plant uptake of metals from soil can be an active as well as a passive process. Moreover, metal bioavailability from soils to plants is a highly site-specific process. This rationale is not a valid reason for considering plant uptake of contaminants deposited as windblown particulates on soil as an incomplete pathway, and as such is unacceptable.

- Tilling may indeed dilute surface contaminant concentrations. However, dilution does not necessarily make the pathway incomplete. Such considerations as the toxicity of the contaminant and the initial surface concentration must be evaluated.

- Simply because the relative importance of a pathway is less than others does not mean that the pathway necessarily should be eliminated from consideration in the baseline risk assessment. The

point is to determine the extent of possible contamination. Potential current effects on off-site residents should be characterized as completely as possible.

Response: Dermal contact with off-site sediments is believed to be negligible because RFP meets current discharge limits per their surface water management plan. Therefore, off-site individuals come into contact with waters that meet discharge permit levels. Since the waters comply with discharge limits, it is assumed that associated sediments are not of concern.

DOE continues to believe that estimating risk due to plant uptake off-site is unreasonable because of the extreme dilution associated with aerial transport and mixing throughout the root zone. Conservative estimates of dilution as a result of Gaussian dispersion to an off-site garden, couple with tilling of the top 15 cm of the garden soil, result in a dilution factor of at least 60,000 following 30 years of deposition. Dilution due to Gaussian dispersion is estimated to result in an annual deposition rate of less than 100 mg/m^2 of OU 2 particulates on garden soil at the location of the off-site residential receptor. This value is conservative, because the model actually predicts this deposition rate at a distance of one mile from the source. Using a tilling depth of 15 cm and a soil density of 1.2 g/cm^3 results in a total dilution factor of at least 1.8 million for each year's deposition. Assuming that aerially deposited contaminants accumulate at the same rate for a period of 30 years yields a total dilution factor of at least 60,000. Of course, the use of soil amendments would result in further dilution. Therefore, the additive exposure associated with plant uptake from the soil (compared to deposition of foliar parts) is insignificant.

DOE believes that conceivable concentrations of radioactive materials from OU 2 in off-site areas may represent a relatively significant radiation exposure due to the amount of radioactive material present. This pathway will therefore be assessed quantitatively in the risk assessment.

The evaluation of potential exposures to site contaminants via ingestion of fruit will be added to the evaluation of current and hypothetical future residential exposures. The specific values for fruit consumption will be the RME value of 42 grams/day, as recommended in the EPA Standard Default Exposure Factors (OSWER Directive 9285.6-03).

CDH S-24: Section 4.5.2.2

Comment: In addition to those potential exposure routes listed, the future construction worker scenario also should include stormwater runoff (exposure to sediments in construction sites) and infiltration and percolation (exposure to shallow ground water in construction sites). As mentioned previously, exposure to outdoor VOCs should be included under volatilization. Figure 4-1, the Conceptual Site Model should be corrected to show these additions.

As mentioned before, because current workers are monitored by a strict Health and Safety Program, does not release DOE from evaluating a given pathway.

Response: Exposure to sediments at future construction sites for future construction workers is the same as exposure to subsurface soils, which is being quantitatively evaluated. Exposure to shallow groundwater would be unlikely during foundation construction for industrial or residential buildings due to dewatering activities. Also see response to CDH S-22, second paragraph.

DOE is evaluating relevant exposure pathways for the current on-site worker even though a health and safety program exists at RFP.

CDH S-25: Section 4.5.2.3

The discussion of future on-site office workers and construction workers should be separated so that it is clear which potential chemical release mechanisms apply to which receptor.

Also, the Division contends that future construction workers will not work only in the industrial complex. Therefore, direct contact with surface water as well as to UHSU ground water discharged into surface water entirely plausible, and exposures to these pathways must be evaluated.

Both the text and Figure 4-1 indicate that direct contact with soils represents significant exposures for office workers and insignificant exposures for construction workers. This is mixed up, and should be corrected.

Response: The discussions will be separated. Physical contact with surface water is not reasonable for future construction workers. The scenario as defined is only for construction of a subsurface basement. Homes and buildings would not likely be built in the surface water drainages. Text and Figure 4-1 will be corrected.

The exposure pathways for the office worker will be changed to "Insignificant." The "Insignificant" for the construction worker is due to the frequency of contact with soils.

CDH S-26: Section 4.5.2.4

Comment: It is entirely plausible that environmental research and clean-up companies might work at RFP in the event that some of the decontaminated buildings become commercial. In that case, it would be possible for future environmental researchers to work indoors on site and be exposed to indoor VOCs.

Response: Typically, ecological research would involve a combination of periodic field work coupled with extensive time in the library, office, or laboratory. This work includes reviewing existing literature, compiling the raw data, performing statistical analyses, preparing tables and graphics, and writing text. Recently, Dr. Ward Whicker of Colorado State University, who has performed extensive ecological research at RFP, estimated that a reasonable estimate for a typical researcher would include field work for 4 hours per day 5 days per week, 13 weeks per year for 2.5 years. It is unlikely that the libraries and laboratories would be located on site. Office time would be minimal and the on-site office worker would bound this exposure. Currently at RFP, environmental clean-up companies spend their indoor time in trailers and, therefore, would not be exposed to subsurface VOCs.

CDH S-27: Section 4.5.2.5

Comment: Fruit consumption as well as vegetable consumption must be considered for all appropriate receptors.

Response: The evaluation of potential exposures to site contaminants via ingestion of fruit will be added to the evaluation of current and hypothetical future residential exposures. The specific values for fruit consumption will be the RME value of 42 grams/day, as recommended in the EPA Standard Default Exposure Factors (OSWER Directive 9285.6-03).

CDH S-28: Figure 4-1

Comment: Oral and dermal exposures to surface water and sediment for the current on-site worker should be changed from "N" to "I".

In addition, dermal contact to LHSU ground water should be added to the figure and an "I" should appear for future on-site residents. The remaining receptors to this pathway would be "N".

Response: The current on-site worker is a guard who does not contact sediment or surface water during routine patrols of OU 2.

DOE disagrees. See response to Specific Comment Number 12. LHSU contamination will be addressed in the bedrock program.

CDH S-29: Section 5.0

Comment: In the second paragraph, ground water and sediments should also be included in this list.

As we stated in our previous review of the draft TM 5, the Division insists that exposures to children and to adults for all appropriate media be evaluated separately. The Division does not agree with the statement in the text that "body weight is not exactly proportional to surface area and age-specific body weight/inhalation rates differ by factors of two or less." Children often are the most sensitive populations to a given toxic effect. Inhalation rate is inversely related to body weight, and total deposition of air particles in the respiratory tract for children is higher than it is for adults (Xu and Yu, Aerosol Science and Technology 5: 349-357, 1986). Therefore, DOE must quantitatively estimate child residential exposures for all exposure pathways, not just for soil ingestion.

Response: Groundwater and sediments will be added to the list of potential media.

Except for the ingestion of soil, for which intake during childhood is significantly higher than for adults, DOE does not believe that it is appropriate to evaluate children as a separate receptor subpopulation. The basis for this determination include (1) the lack of specific guidance from EPA on assessing such exposure, (2) the lack of benchmark toxicity values for characterizing risks associated with subchronic exposures, and (3) the possibility that the available benchmark inhalation toxicity values (RfCs) already incorporate an adjustment to protect for childhood intakes.

CDH S-30: Section 5.1.1

Comment: The Division is uncomfortable with the use of 60 days of snowcover because inhalation of particulates is not necessarily limited to days when there is no snow. Dirt and mud can be tracked indoors even on snowy days, and ingested or inhaled. However, if DOE limits their use of some of the other techniques they have proposed to "fine-tune" the RME estimates of contact times, we would be willing to accept the decrease from 350 days to 290 days because of snowcover. Note that the use of 60 days of snowcover does not give an RME estimate, and as such, DOE is likely to underestimate exposures and risks.

Response: DOE will use 350 days exposure frequency for inhalation of particulates.

The current literature regarding the relative contribution of outdoor soil to indoor dust is inconclusive. DOE assumes that, even for individuals who spend all of their time at home, only half of the ingested soil or dust originates as contaminated media. The other half includes dust from more distant sources, as well as a variety of indoor sources unrelated to outdoor soils. Therefore, DOE will use an FI value of 0.5.

CDH S-31: Section 5.1.2

Comment: A conservative respiratory rate for construction workers would be a 1.4 m^3/day as used for the landfill workers in OU 7. This would be a more appropriate rate than the standard RME value of 0.83 m^3/day.

The most sensitive populations (invalids, young children, retired people) spend the majority of their time at home. Therefore, it is not appropriate to use a 16 hour exposure time instead of a 24 exposure time.

In order to protect the susceptible populations, the Division again recommends that the exposure times (ET) for residents be changed to

24 hours/day and that the fraction contacted (FC) (if it is used) be changed to 1.0 from 0.5.

The state does not agree with the use of a lung deposition factor for an RME estimate. Moreover, while the statement that "25% of inhaled particles are deposited in the lungs" is true per se, deposition can also occur in other parts of the respiratory system where it can exert health effects. The same table in the same study (EPA 1985) that listed the 25% lung deposition also states that 50% of inhaled particles are deposited in the upper respiratory passages and subsequently swallowed. These chemicals are thus retained in the body and could be absorbed and exert toxic effects. Baseline risk assessments are concerned with overall health effects, and not simply lung effects. Therefore, if used at all, the usual value for depositional fraction is 75%.

Response: A value of 1.4 m^3/d will be used for the construction worker respiratory rate. DOE will also use 24 hr/day exposure, 350 days per year.

The current literature regarding the relative contribution of outdoor soil to indoor dust is inconclusive. DOE assumes that, even for individuals who spend all of their time at home, only half of the ingested soil or dust originates as contaminated media. The other half includes dust from more distant sources, as well as a variety of indoor sources unrelated to outdoor soils. Therefore, DOE will use an FI value of 0.5.

DOE will use the recommended value of 75 percent for the percentage of inhaled particles that are deposited in the lung.

CDH S-32: Section 5.1.3

Comment: A value of 50 mg/day of soil in the RME case for most occupational receptors is acceptable. However, OSWER Directive 9285.6-03 suggests that a value of 480 mg/day of soil be used for outdoor activities like construction and landscaping.

Fraction Ingested (FI) factors should not be used. The calculation for the future on-site ecological researcher is based area, not time, and is, therefore, unacceptable. Depending upon the research project, it is entirely conceivable that an ecological researcher could spend the vast majority of time in one area like OU 2 or a small portion (including the IHSS's) of OU 2. Averaging the exposure over the whole RFP buffer zone will dilute any exposure. The result is that DOE's proposed method is not protective in the remotest sense. In addition, RAGS (6.6.2) suggests that concentrations in indoor dust can be equal to outdoor dust. Therefore, FI should be equal to 1.0, not 0.5, for the residential exposure scenario.

Soil matrix factors should not be used to modify soil ingestion exposures. The usefulness of soil matrix values and the availability of appropriate site-specific and chemical-specific values in the literature is questioned.

Response: The 480 mg/day soil ingestion value is from Hawley (1985), which relied on the modeling of assumptions regarding contact rates and body surface area to estimate soil ingestion for adult residents doing yardwork. The 50 mg/day value is based on quantitative tracer studies of adults who worked outside the home. The methodology used in Hawley (1985) is unreliable for quantitative estimates. The OSWER directive actually states that "480 mg/day may be used; however, ... exposure frequency would generally be less than one year and exposure duration would vary according to site-specific construction plans." Therefore, it is believed that 50 mg/day is the best value for occupational exposures at OU 2.

DOE agrees to base the exposure for the on-site ecological researcher solely on time, not area. In developing exposure assumptions for a potential ecological researcher scenario, DOE is attempting to produce a conservative but reasonable exposure. The assumptions used in this scenario were developed based on input from various sources, including Dr. Ward Whicker of Colorado State University, who has conducted considerable research at RFP and elsewhere. Ecological research includes

a combination of field work, laboratory work, and office work; collecting samples or making observations at the site are typically not full-time efforts. Agency comments would tend to drive this scenario toward those identical to the future on-site office worker. DOE believes that this approach would be neither realistic nor appropriate. We believe that this is the correct approach for two reasons: first, there is no reason to separately address this receptor if it becomes identical to a full-time on-site worker, as CDH seems to be heading; second, using multiple "worst-case" assumptions results in an exposure frequency and duration that is neither reasonable (as appropriate for an RME) nor realistic. See response to CDH S-26.

DOE believes that a fraction ingested (FI) value of 0.5 for the future on-site worker is most appropriate. This assumes that 50 percent of ingested soil or dust originates as contaminated media. See General Response Number 7.

For some compounds, the ability of soils to bind the chemical can be significant, especially in its effects on the availability of the compound for dermal exposures. Chemical-specific information regarding the ability of soil to bind compounds so as to reduce their availability for human exposure will be submitted to CDH and EPA for review and approval as a part of the toxicity technical memorandum.

CDH S-33: Section 5.1.4.

Comment: The discussion of matrix effect on produce bioavailability is unclear. What kind of matrix values is DOE proposing to use? Chemical-specific values are only rarely available.

Response: A bioavailability value will not be used to estimate human absorption of contaminants taken up into plants. It is anticipated that much of the exposure to site-related contaminants via ingestion of home-grown produce will be the result of the aerial deposition of soils onto the surfaces of

plants. Therefore, DOE will assume that the bioavailability of contaminants in soil will also apply to contaminants in resuspended soil deposited on plants.

CDH S-34: Section 5.1.5

Comment: A future ecological researcher is likely to be exposed to surface water and sediment many more times than 7/year. 7 events/year is unacceptable for this receptor. The OU 1 PHE used 1 day/week.

Response: A researcher is not a full-time caretaker. Typically, ecological research would involve a combination of periodic field work coupled with extensive time in the library, office, or laboratory. This work includes reviewing existing literature, compiling the raw data, performing statistical analyses, preparing tables and graphics, and writing text. Recently, Dr. Ward Whicker of Colorado State University, who has performed extensive ecological research at RFP, estimated that a reasonable estimate for a typical researcher at OU 2 would include field work for 4 hours per day, 5 days per week, 13 weeks per year, over a period of 2.5 years. For this exposure time, it is reasonable that an ecological researcher would contact surface water 7 times per year.

CDH S-35: Section 5.1.6

Comment: The RME value of 2910 cm^2/day for exposed body surface area is inappropriate for residential receptors. Residential receptors are likely to expose more than just the face, forearms and hands. Moreover, the reference cited is not the latest guidance. While 2910 cm^2/day would be OK for most occupational receptors, EPA 1992, "Dermal Exposure Assessment: Principles and Applications" notes that clothing is not fully protective against exposure to many chemicals. Thus, a higher surface area value should be used.

The current RME soil adherence value is not 0.5 mg/cm^2. EPA 1992, "Dermal Exposure Assessment: Principles and Applications" recommends a range, 0.2 mg/cm^2 - 1.5 mg/cm^2 per event. A value of 0.9 mg/cm^2 was used in the OU 1 PHE. Values such as this should be standardized for all RF health evaluations.

The Division reiterates our disagreement with the fraction contacted (FC) values presented for the future on-site ecological worker and the current and future residential receptors. Depending upon the research project, it is entirely conceivable that an ecological researcher could spend the vast majority of time in one area like OU 2 or a small portion (including the IHSS's) of OU 2. In order to protect the susceptible populations, the Division recommends that the fraction contacted (FC) (if it is used) be changed to 1.0 from 0.5 for future and current residential receptors.

Response: Based on information presented in the EPA's Exposure Factors handbook, a typical exposure case (i.e., individual wears long sleeve shirt, pants and shoes) the exposed skin surface is estimated to be 2,000 cm^2. The most recent guidance in the Interim Guidance for Dermal Exposure Assessment recommends use of the upper end of the range for exposed skin area as 5,000 cm^2 for adults (hands, legs, arms, neck, and head). Because the residential exposure scenario is intended to characterize average exposures over all seasons, this recommended default value of 5,000 cm^2 is conservative for evaluating this exposure scenario. Since a "typical case" exposure is defined to be limited to 2,000 cm^2, DOE believes that assessing the ecological researcher and residential exposure at 2,910 cm^2 is adequately protective.

An average soil adherence value of 0.5 mg/cm^2 will be used in conjunction with other RME values to estimate dermal exposure to soils so as to not overestimate exposures by using the most conservative value for each assumption. The range of values cited in EPA 1992 will be used in a quantitative uncertainty analysis of dermal contact with soil if it is a driving pathway in the risk assessment.

When providing risk estimates for a hazardous waste site, the objectives and guidelines provided by EPA are to define a conservative but reasonable estimate, usually the 95th percentile of maximum probable risk. (See EPA 1991b, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual. Supplemental Guidance, "Standard Default Exposure Factors." OSWER Directive 9285.6-03, Page 2.) (Also see Federal Register, Volume 57, Number 104, Page 22922, Friday, May 29, 1992.) Because the derivation of the risk estimates are a combination of many different individual assumptions, the use of the most conservative value for each assumption may lead to an estimate of exposure (and risk) that is unreasonable and far above the 95th percentile. Compounding extreme conservatism can result in a total exposure that is unrealistic and can inappropriately influence the establishment of cleanup criteria and evaluation of remediation alternatives. DOE believes that the scenarios described in this technical memorandum, as revised, are amply conservative and consistent with EPA guidelines.

The current literature regarding the relative contribution of outdoor soil to indoor dust is inconclusive. DOE assumes that, even for individuals who spend all of their time at home, only half of the ingested soil or dust originates as contaminated media. The other half includes dust from more distant sources, as well as a variety of indoor sources unrelated to outdoor soils. Therefore, DOE will use an FI value of 0.5.

CDH S-36: Section 5.1.7

Comment: It is unclear from this discussion whether actual sediment concentrations of metals or chemicals are going to be factored into the surface water model. What is "a suspended sediment factor"?

A researcher is likely to be exposed to surface water for more than 7 events/year. This value is not acceptable.

Response: Dermal contact with sediments at OU 2 is assumed to result from activities such as wading that suspend some sediment in the aqueous medium. Therefore, a portion of sediment suspended during wading activities is defined as the suspended sediment factor.

See response to Specific Comment Number 34.

CDH S-37: Table 5-1

Comment: How are children factored into the 0.83 m^3/hr inhalation rate?

Response: See response to General Comment Number 3.

CDH S-38: Tables 5-9, 5-10, and 5-11

Comment: The combination of an EF of 30 days/yr and ED of 1.0 years for a future on-site construction worker is not reasonable. A future on-site construction worker could be involved in home building, road construction, utility construction and maintenance, office or industrial construction, etc. Most of these activities, if confined to one calendar year, would last more than 30 days. Conversely, if they only last 30 days, they would probably be repetitive and cover more than one calendar year. Either one or both of these factors should be increased to a more reasonable value.

Response: The construction of a housing subdivision or commercial building foundation is estimated by design engineers to take 30 days at most. The same workers would not likely be involved in every residential or commercial building development project that occurred on site at various points in the future.

Response to DOE General Comments

DOE G-1:

Comment: Our first major concern with the document is that the site descriptions in Section 2.1 indicate that all Individual Hazardous Substance Sites (IHSS's) in OU 2 (with the possible exceptions of the Reactive Metal Destruction Site, the Gas Detoxification Site and the East Spray Irrigation Sites) have had the surface soil removed or covered with asphalt or clean soil. If these descriptions are correct, it would appear that there is no major source of contaminants to be released via the postulated surface soil-related release mechanisms. There may be no complete exposure pathways associated with surface soils. Please discuss this issue further.

Response: The extent of clean-up of the areas discussed in Section 2.1 was not risk based. Therefore, sampling of these areas will determine whether any remaining contamination poses a potential health risk.

DOE G-2:

Comment: Our other major concern is that this document assumes the source areas for contaminated surface soil are the IHSS's. The surface soil sampling proposed in Technical Memorandum (TM) Number (No.) 7 (January 1993) for this OU specifies only 6 samples in the IHSS's, 2 in the 903 Pad Area, 2 in the Mound, and 2 in the East Trenches. If surface soil contamination does exist, the analytical results from these 6 samples are unlikely to be adequate for risk assessment or for the contaminant transport modeling proposed, especially given the disparate disposal histories of these IHSS's. TM No. 7 also recommends reconnaissance sampling of an area of about 1 square mile east of the IHSS's.

It is unclear how these samples would be used in this Risk Assessment. Recommend that there be more coordination between actual Risk Assessment needs and proposed sampling.

Response: The surface soil sampling plan was designed to address OU 2 wide surface soil contamination. Based ont he fact that the IHSSs have been cleaned-up to some extent and remaining surface soil contamination has likely dispersed over time, a more uniform pattern of contamination would be expected.

DOE G-3:

Comment: Throughout the document, exposure pathways and exposure routes are stated to be significant or insignificant. The decision on the significance of most pathways should be made based on the results of the Risk Assessment. Recommend that exposure pathways simply be designated as complete or incomplete in this document.

Response: Agreed. EPA's Risk Assessment Guidance for Superfund (Part A, Section 3.5) states that a human health evaluation "should be limited to the complexity and level of detail necessary to adequately assess risks..." The relative significance of pathways is typically known from experience and is used to ensure that driving pathways are addressed quantitatively and that unnecessary calculations are not made.

The purpose of the designations was to eliminate incomplete exposure pathways from the risk assessment, to qualitatively address negligible pathways, and to quantitatively evaluate significant or insignificant pathways.

Response to DOE Specific Comments

DOE S-1: Section 1.2, page (p.) 1-2, first paragraph

Comment: This paragraph classifies exposure scenarios as significant, insignificant or negligible. However, Section 3.4 classifies scenarios as improbable, plausible or credible. Section 4.5 applies the significant, insignificant or negligible terminology to exposure pathways and routes. Recommend that

this type of terminology be dropped altogether or at least that consistent terminology be used to describe exposure scenarios.

Response: Consistent terminology will be used in the revised technical memorandum in Sections 1 and 4. The discussions in Section 3 will differ and simply describe potential future land uses as credible or improbable. The following illustrates this terminology for future land uses:

> For the purpose of a qualitative evaluation of potential receptors, future land-use scenarios have been categorized as either improbable (unlikely to occur because of serious constraints) or credible (expected to occur given the right set of circumstances). Table 3-3 presents the probability classification for the five major future land use categories (residential, commercial/industrial, recreational, ecological reserve, and agricultural).
>
> Future land uses considered to be improbable include on-site residential, on-site agriculture, off-site agricultural, and off-site ecological reserve. Both on-site agriculture and on-site residential are considered improbable because of the increasing public interest in preserving unplowed prairie and wetland habitats and protecting wildlife. This is evidenced by ongoing acquisition of open space by Jefferson County, Boulder County, and the City of Boulder (including large tracts near RFP) and the recent designation of the Rocky Mountain Arsenal as a wildlife refuge by the U.S. Fish and Wildlife Service. Like RFP, the Arsenal is a large (27-square mile) RCRA/CERCLA site that was protected from grazing or development because of weapons production and the need for an extensive buffer zone. Additionally, agriculture would offer poor economics compared to commercial/industrial development.
>
> Off-site agriculture is considered to be less likely than residential, commercial/industrial, or recreational uses because of economics as well as increasing public and community interest in preserving open space. This is also consistent with existing regional zoning and land use designations, as discussed in Section 3.2 of the technical memorandum and shown on the figures included in that section. Therefore, although agriculture currently occurs in

nearby off-site areas, it is anticipated that this use will gradually diminish and eventually disappear from parcels closest to the site.

Use of off-site areas as ecological reserves is considered improbable because of the disturbed nature of most parcels (cultivation or heavy grazing) and the proximity to planned commercial/industrial or mixed commercial/residential uses. Exceptions might be stands of cottonwoods near Standley Reservoir, where bald eagles were observed in the winter of 1992-93.

Future on-site land uses considered to be credible include commercial/industrial, recreational, and ecological reserve. Commercial/industrial uses would be appropriate, at least for the present industrialized area of RFP, because of the existing infrastructure, economic advantages, and reduced liability concerns. On-site recreational and ecological reserve would be consistent with the ecological diversity and scenic quality of the site, the existing wildlife use and presence of several species of special concern, the increasing regional interest in habitat preservation and undeveloped recreation, and minimal liability issues.

Credible future off-site uses include commercial/industrial, residential, and recreational. All these are consistent with recent growth and development patterns in the northwestern Denver metropolitan area and are projected in various planning documents (see Section 3.2).

DOE S-2: Section 2.5.3, p. 2-11, second paragraph

Comment: If the seeps along the Walnut Creek drainage are currently being remediated, it is unclear why their contribution to surface water contamination would be included in the risk assessment. Please explain further.

Response: It was incorrectly stated in the technical memorandum that seeps are currently being remediated. Seeps are actually only being treated. The source of seep contamination is not being addressed.

DOE S-3: Section 2.5.4, p. 2-12

Comment: The discussion of the use of ground water from the upper hydrostratigraphic unit (UHSU) (or equivalent off-site units) and in the alluvium of the Walnut and Woman Creek drainages needs to be expanded either here or in the land-use sections. There needs to be a specific statement on whether the UHSU is capable of yielding sufficient water for domestic or drinking purposes and whether that water is potable. This statement is needed to support the inclusion or exclusion of an on-site future residential drinking water scenario (Section 4.5.2.6). While there are apparently no wells currently screened in the alluvium of the creek drainages, the possibility of future wells needs to be assessed to support the contention that off-site ground water will not be used in the future for domestic or drinking purposes.

Response: The No. 1 sandstone that is connected hydraulically to the alluvium can support a residential well. The groundwater in the alluvium and colluvium is not sufficient to support a domestic well.

DOE S-4: Section 4.5, p. 4-5, second paragraph

Comment: Recommend that the significant/insignificant terminology be dropped. Please see General Comment.

Response: The purpose of the designations was to eliminate incomplete exposure pathways from the risk assessment, to qualitatively address negligible pathways, and to quantitatively evaluate significant or insignificant pathways.

DOE S-5: Section 4.5.1, p. 4-6, fourth paragraph

Comment: With the possible exception of dilution in ambient air, the arguments in this paragraph for excluding inhalation of volatile organic compounds (VOC) in outdoor air should also apply to indoor air. Recommend that inhalation of indoor VOCs be deleted as a pathway of concern on this basis. If this deletion is not possible, please revise the paragraph to emphasize the dilution argument for outdoor air.

Response: Dilution of indoor air containing VOC's volatilized from subsurface soils through a foundation does not occur to the same extent as outdoor air prior to the exposure point in a closed building. The paragraph will be revised for clarity.

DOE S-6: Section 4.5.1, p. 4-6, fifth paragraph

Comment: This paragraph is inconsistent with the inclusion of ground water ingestion as a complete future on-site exposure pathway (Table 4-1 and Section 4.5.2.6) and with the assumed contribution of ground water to concentrations of indoor VOCs. Please see also Specific Comment Number 3.

Response: Direct ingestion of groundwater does not involve volatilization of VOCs to outdoor air. Exposure to indoor air VOCs from groundwater is not addressed in this paragraph which discusses volatilization to outdoor (ambient) air.

DOE S-7: Section 4.5.2, p. 4-7 to 4-19

Comment: This section contains much repetitive material. For example all 6 subsections begin with the same sentence listing potential chemical release mechanisms, and restates in each subsection that ground water and storm runoff contribute to surface water contamination. Suggest that the chemical release mechanism and the general potential pathway discussions

be done once at the beginning of Section 4.5 and that the 4.5.2 subsections simply state why particular pathways are included or excluded for a given scenario.

Response: Conceptual site models (Figure 4-1) are a challenge to explain, and it is believed that the current explanation is sufficient.

DOE S-8: Section 4.5.2.1, p. 4-8, second paragraph

Comment: The implication that dermal absorption is relatively insignificant with respect to ingestion for soils is incorrect. Risks associated with the two exposure routes for soils are comparable.

Response: It is believed that the relative significance of the two exposure routes is correct as stated; however, we intend to assess both the significant and insignificant exposure routes quantitatively.

DOE S-9: Section 4.5.2.1, p. 4-8, third paragraph

Comment: It is unclear why radionuclides should be excluded from consideration based on expected low concentrations. Radionuclides are the only contaminants for which historical evidence exists for significant wind dispersion. Please explain.

Response: Radionuclide exposure to off-site residents will be addressed in the revised technical memorandum due to the relatively high source term in surface soils at OU 2.

DOE S-10: Section 4.5.2.1, p. 4-9, first and second paragraph

Comment: The arguments against considering plant uptake from soils are not correct. The first bullet limits the discussion to metals when there is no basis for excluding organic compounds. The statement in the next paragraph that intake from ingestion and dermal contact will greatly exceed the intake is

incorrect; for organic compounds intake from plant ingestion usually exceeds intake from soil ingestion or dermal contact by an order of magnitude or more. Recommend that plant uptake from soils be carried through the Risk Assessment.

Response: It is believed that estimating risk due to plant uptake off-site is unreasonable because of the extreme dilution associated with aerial transport and mixing throughout the root zone. Conservative estimates of dilution as a result of Gaussian dispersion to an off-site garden, couple with tilling of the top 15 cm of the garden soil, result in a dilution factor of at least 60,000 following 30 years of deposition. Dilution due to Gaussian dispersion is estimated to result in an annual deposition rate of less than 100 mg/m^2 of OU 2 particulates on garden soil at the location of the off-site residential receptor. This value is conservative, because the model actually predicts this deposition rate at a distance of one mile from the source. Using a tilling depth of 15 cm and a soil density of 1.2 g/cm^3 results in a total dilution factor of at least 1.8 million for each year's deposition. Assuming that aerially deposited contaminants accumulate at the same rate for a period of 30 years yields a total dilution factor of at least 60,000. Of course, the use of soil amendments would result in further dilution. Therefore, the additive exposure associated with plant uptake from the soil (compared to deposition of foliar parts) is insignificant.

DOE S-11: Section 4.5.2.3, p. 4-12, fifth paragraph

Comment: The statements in the first sentence concerning the significance of scenarios and exposure routes are incorrect. Direct contact with soils would be expected to be more significant for construction workers, who may be in intimate contact with soils during excavations, than for office workers, and intake via dermal contact and ingestion are comparable. Again, recommend that such statements be dropped.

Response: The text is incorrect as written; "significant" and "insignificant" were inadvertently switched.

DOE S-12: Section 4.5.2.4, p. 4-13, third paragraph

Comment: For surface water, exposure via dermal contact is usually much more significant than incidental ingestion, contrary to what is stated here. Given the intermittent nature of the streams and the fact that the ecological researcher would be highly unlikely to be swimming, incidental ingestion would be expected to be negligible in this case. The statements on relative significance should be dropped or corrected. In addition to dermal contact with water, dermal contact with sediments could be an important exposure route. Recommend that this exposure route be added to the Risk Assessment.

Response: This would be true for the ecological researcher. The statements on significance will be corrected. Dermal contact with sediments is addressed for the ecological researcher and future on- and off-site residents (see Figure 4-1).

DOE S-13: Section 4.5.2.4, p. 4-13, top of page

Comment: Please see Specific Comment Number 5.

Response: See response to specific Comment Number 5.

DOE S-14: Section 4.5.2.5, p. 4-15, second paragraph

Comment: Given the intermittent nature of the streams and the difficulty of access it would appear highly unlikely that residents would have significant exposure to the creeks. Recommend that this exposure pathway be deleted for the residential scenario. See also Specific Comment Number 12.

Response: Exposures to surface water and sediments will be addressed for future residents only, due to the assumption that there will be no control of stormwater in the future. There is not significant exposure to the creeks. The EF is equal to only 18 hours/yr.

DOE S-15: Section 4.5.2.5, p. 4-15, third paragraph

Comment: The fact that there are currently no domestic wells in the alluvium of the Woman Creek and Walnut Creek drainages does not preclude future domestic wells in those locations. Arguments against the future use of ground water off site need to be based on the hydraulic nature of the geological units or the quality of the water. Please see also Specific Comment Number 3.

Response: Please see response to Specific Comment Number 3.

DOE S-16: Section 4.5.2.5, p. 4-16, second and third paragraph

Comment: Material is repeated verbatim from an earlier section. Please see Specific Comment Number 10.

Response: The text will be revised as described in the response to specific Comment Number 10.

DOE S-17: Section 4.5.2.5, p. 4-16, fourth paragraph

Comment: Material is repeated verbatim from an earlier section. Please see Specific Comment Number 9.

Response: The text will be revised as described in the response to Specific Comment Number 9.

DOE S-18: Section 4.5.2.6, p. 4-17, fourth paragraph

Comment: Please discuss the evidence that the hydraulic properties of the UHSU are suitable for domestic wells. Please see also Specific Comment Number 3. In addition, if the unit is suitable for drinking water wells, water from the unit would probably also be used for other domestic purposes such as bathing. If ground water ingestion is considered a complete pathway, dermal contact and inhalation of VOCs should be added as complete pathways.

Response: See response to Specific Comment Number 3. Inhalation of VOCs volatilized from UHSU groundwater is addressed for the future on-site resident (see Figure 4-1). Dermal contact is typically insignificant compared to groundwater ingestion.

DOE S-19: Section 4.5.2.6, p. 4-18, second paragraph

Comment: For organic compounds intake from plant ingestion usually exceeds intake from soil ingestion or dermal contact by an order of magnitude or more. Please correct the statements to the contrary in this paragraph.

Response: Comment noted. Text will be revised.

DOE S-20: Section 5.0, p. 5-2, top of page

Comment: The units in the equation are correct only for water or air. Units for soil or plants are usually mg/kg and mg/day for concentration and ingestion rate, respectively. Since all units are given in the tables, this equation could be deleted. Please correct or delete.

Response: Comment noted. The equation is intended for explanation of units only.

DOE S-21: Section 5.1.5, p. 5-8, first paragraph

Comment: Both the ingestion rate and the exposure frequency used for the surface water pathway are generally considered appropriate for swimming. Given the nature of the creeks, it seems unlikely that either an ecological worker or a resident would be immersed in the creeks. Suggest that the ingestion rate be lowered or that the ingestion pathway be deleted altogether since it is unlikely to be important. The exposure frequency is probably reasonable but should be considered a site-specific variable not referenced to Environmental Protection Agency (EPA) 1989a. Please see also Specific Comment Numbers 12 and 14.

Response: Agreed. The lack of available information on this activity pattern resulted in a conservative extrapolation of wading to swimming. Typically, ecological research would involve a combination of periodic field work coupled with extensive time in the library, office, or laboratory. This work includes reviewing existing literature, compiling the raw data, performing statistical analyses, preparing tables and graphics, and writing text. Recently, Dr. Ward Whicker of Colorado State University, who has performed extensive ecological research at RFP, estimated that a reasonable estimate for a typical researcher at OU 2 would include field work for 4 hours per day, 13 weeks per year, over a period of 2.5 years.

DOE S-22: Section 5.1.7, p. 5-10, first paragraph

Comment: The exposure frequency and exposure time are probably reasonable but should be considered site-specific variables not referenced to EPA 1989a since that document assumes a swimmer scenario. Water permeability constants for most organic chemicals are given in Dermal Exposure Assessment: Principles and Applications (EPA 1992) or can be calculated from empirical formulas; there is no need to reference a single default values as is done here. Please see also Specific Comment Numbers 12 and 14.

Response: Chemical-specific permeability constants, if available, will be determined from appropriate, current literature. This information will be submitted for review and approval prior to inclusion in the Toxicity Assessment Technical Memorandum. EPA and CDH will have an opportunity to review the methodology and specific values to be used at the time.